Weir

Technical Information

413 & 423

BENCH VARIABLE

POWER SUPPLIES

R. D. D

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413 & 423

BENCH VARIABLE POWER SUPPLIES

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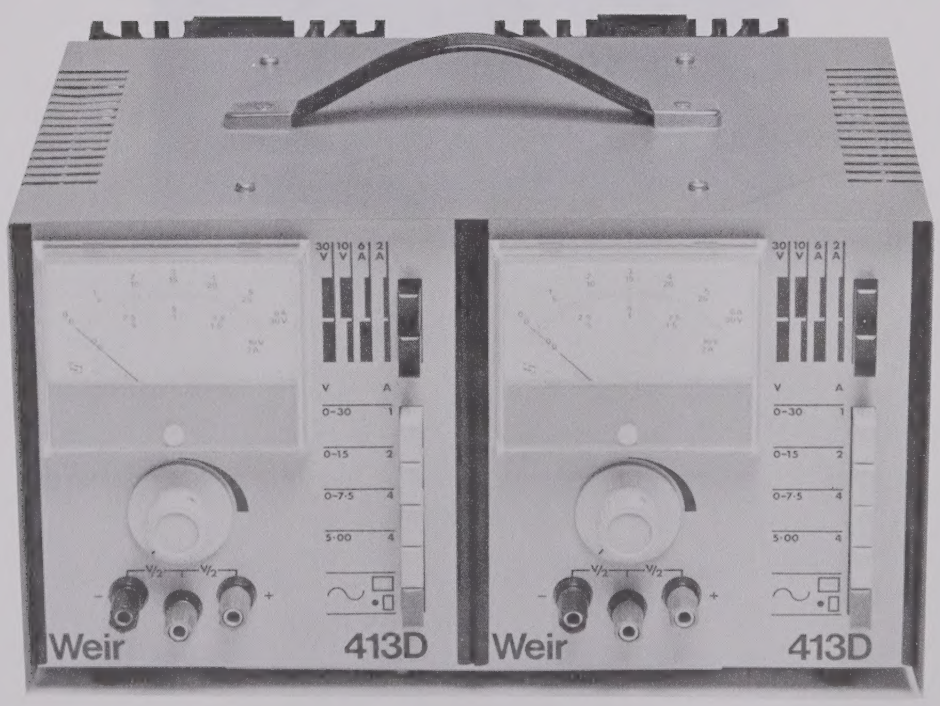

Fig.1 Front View of 413D used in Twin Pack Configuration

1.0 INTRODUCTION

The bench power supplies types 413 and 423 are four range units providing the following outputs:-

413	0-30V at 1·0A;	0-15V at 2·0A;	0-7·5V at 4·0A;	5V at 4·0A
423	0-60V at 0·5A;	0-30V at 1·0A;	0-15V at 2·0A;	5V at 2·0A

In addition, a 'D' option on each unit provides a centre tap, the accuracy of which is specified down to a total supply voltage of 4V (i.e., ±2V supply). A further 'T' option gives a 10-turn voltage control with dial for increased resolution and resettability.

All units use the same basic case and internal construction with identical heatsinks and main printed circuit board, changes to component values and types determining the difference between the units. The 'D' option variants have an additional circuit board which controls the centre tap, together with a pair of extra power transistors on the heatsink.

2.0 OPERATING INSTRUCTIONS

The unit requires a 50 to 60Hz AC ONLY input power supply. The captive power lead to the instrument should be connected to a 3-pin power plug. The lead is colour coded:- brown = live, blue = neutral and green/yellow = earth (see Safety Regulations 64.2 (a) 3 and 64.3 (c) 5).

⚠ INCORRECT CONNECTION OF THE POWER LEAD, OR CONNECTION TO A SUPPLY WITH NO EARTH, IS DANGEROUS.

Set the voltage selector on the rear of the unit to the correct input supply voltage and check the fuse rating (see Parts List and Safety Regulations 64.5 (c)), connect the a.c. supply and switch on by depressing the red push-button which latches in. The unit is switched off by a second depression of the button which releases the latch.

With none of the grey 'range select' push-buttons depressed, the supply gives no output. Depress the push-button for the supply range desired, noting that the lowest grey button gives a 5V output regardless of the position of the voltage potentiometer. In order to avoid possible damage to loads caused by inadvertent range changing, the push-buttons are independently operated. To change ranges, release the already selected range by pushing the button a second time, then depress the button for the new range required.

If more than one grey button is depressed at a time, the output supply will correspond to the lowest selected voltage and the output current limit to the lowest selected current. This facility can be of use if a current limit lower than the maximum is required on any of the lower voltage ranges.

The output voltage control potentiometer is not calibrated; however, the front panel markings (or the dial settings on 'T' versions) can be used for resetting to a previously set voltage. Note that, in order to ensure full voltage availability on all ranges, a small amount of voltage overrange is provided. Similarly, in order to ensure full current availability, the nominal current limit values are 10% higher than the values marked.

On 'D' versions, the centre tap voltage is guaranteed to be 49 to 51% of the output voltage ±100mV down to 4V total output. The current limit will operate if the current in either half of the supply exceeds the limit value. Both halves of the supply, however, will be reduced in voltage together as the current limit operates.

With both black push-buttons released, the meter reads output voltage with a full scale equal to the highest range. Depressing the top meter push-button changes the meter to current reading. Depressing the lower button increases the meter sensitivity by a factor of 3 on both voltage and current. There are, thus, a total of four meter ranges. On centre tapped units ('D' option), the meter reads the total supply voltage on voltage ranges and whichever is the highest of the load currents on current ranges.

To obtain extra power, higher voltage or multi-rail configurations, units may be connected in series. Parallel operation is not recommended; unless the output voltages are set precisely equal, a step in output voltage will occur at half the total output current as one unit enters 'current limit'. The multi-range capability of these units largely obviates the need for parallel operation. For example, if 30V at 2A is required from two 413 or 423 units, set both to 15V at 2A and connect them in series, rather than setting them to 30V at 1A and connecting them in parallel.

NOTE: Before connecting the power supply to the load circuit, refer to Safety Regulations 64.3 (a) 6 (a), 64.3 (e) 6 (b) and 64.4 (a) 7. For output voltage in excess of 42V, available from the 423, it is recommended that the supply is switched off before connecting to the load (see Safety Regulations 64.5 (b) (b)).

The power supplies may be used in series for voltages up to 300V d.c. which are dangerous. Care must be taken to shield the output terminals (see Safety Regulations 64.4 (b) (b).

All supplies in the range rely on adequate cooling of the heatsink and internal components for correct operation. DO NOT obstruct the airflow by placing other equipment or papers on top of the units when they are operating.

TWIN PACK BENCH VARIABLE POWER SUPPLIES

Any combination of units from the following list of Mini 400 Series Power Supplies may be specified in Twin Pack dual power supply configurations:-

413, 423, 413D, 423D, 400, 430 and 460.

Any unit may have the 'T' option, i.e., 10-turn variable voltage potentiometer for fine resettable linear control.

3.0 TECHNICAL DESCRIPTION

This description should be read in conjunction with Fig. 2 (The Power Supply Circuit Diagram). The a.c. input is fused by FS1, double-pole switched by S7A and S7B and applied to the transformer primary via the voltage selector. This connects the primaries in series or parallel and adjusts the taps to suit the input voltage. The secondaries are connected in series or parallel by S3A, S4A, S5A and S6A to provide the correct unregulated voltage for the selected range.

With S6 or S5 depressed, secondary 3 is connected in parallel with the series combination of secondaries 1 and 2 to give the lowest voltage, highest current output to the rectifier. If either S3 or S4 is depressed at the same time, the combination of secondaries 1 and 2 is disconnected; as this action automatically lowers the current limit, secondary 3 can supply the load. With S4 depressed, secondaries 1 and 3 are connected in series for the middle output range; depressing S3 simultaneously with S4 has no effect as S4 has disconnected one end of the secondary 2. With S3 depressed, secondaries 1, 2 and 3 are connected in series to supply the highest voltage range.

The a.c. output from the transformer is rectified by MR2, MR3, MR4 and MR5 (BR1 on 413), with C2 acting as the reservoir capacitor. VT10 and VT11 are the series regulator transistors with R29 providing current sensing. R29 and R30 also act to ensure current sharing between VT10 and VT11. The output is decoupled by C8 (C13 on centre tapped units) with MR13 acting as protection against a reverse voltage being applied to the output terminals.

Secondary 4 of the transformer is a low current secondary supplying power to the control and driver circuits. Its output is rectified by MR1 and filtered by C1. Note that the negative rail of the control supply is common to the positive rail of the output. R21, R22, VT8 and MR12 act as a constant current source supplying current to the main reference rail. This rail is stabilised by the amplifier VT6 and VT7, with MR11 acting as feedback round this amplifier. The regulated rail is, therefore, 5·6V plus the base emitter forward voltage of VT6 and appears at the emitter of VT7. R19 sets the standing current through MR11. The excess current from the collector of VT7 is used as the base drive for the drive transistor VT9.

R2 and RV2 provide a preset adjustable voltage for the voltage amplifier on the variable ranges. R5, R6 and R7 convert this into a reference current. Depressing S5 connects R5, R6 and R7 in series to provide the lowest reference current and, hence, the lowest output voltage range; as S5B has disconnected S4B and S3B, depressing these simultaneously does not affect the output voltage. Depressing S4 connects R5 and R6 in series to give the middle range; again, S4B disconnects S3B so that depressing S3B does not affect the output voltage. With S3 depressed, R5 provides the reference current. This switching arrangement ensures that the output is always the lowest of the selected voltages.

The reference circuit is balanced against the feedback current drawn by RV6 through MR7 and, as the base current of VT1 is negligible, these are equal. Note that, as the bases of VT1 and VT6 are both one forward-biased diode voltage drop above the positive output, their emitter base voltage drops cancel and MR11 determines the voltage across R5, R6 and R7. Similarly, the forward voltage drop of MR7 cancels the forward voltage drop of VT1 base, so that the voltage across RV6 is equal to the output voltage. Temperature variations in VT1, VT6 and MR7, therefore, cancel.

The action of the feedback loop is as follows:- Should the output voltage increase, the extra current through RV6 causes VT1 to turn off slightly, reducing its collector current. Some of the current from R8, therefore, diverts through MR9 and into the emitter of the common base stage VT3. This current flows from the collector of VT3 into the base of VT4, causing its collector current to increase. As a result, the emitter follower VT5 also draws more current from VT7, reducing the drive to VT9 and, hence, the output stages. This, therefore, causes a change in output to oppose the initial change and stabilises the output voltage.

C3 gives increased gain at a.c. to minimise ripple. R42 helps to define the gain of VT1. R17 and C4 provide the main loop time constants. C14 and C7 suppress possible parasitic oscillations. When S6 is depressed, the variable control system is disconnected from VT1 base. An adjustable reference current through R3 and RV3 and a fixed feedback current through R4 and MR6 are connected to VT1 base to give the fixed 5V output.

The current limit circuitry operates in a similar manner. The reference current is derived from the adjustable divider R1 and RV1, with R9, R10 and R11 as the series resistors. The switching in this case is arranged to allow only the lowest current limit selected to operate. The feedback current is through R12 and MR8. The voltage drop across MR8 cancels the base emitter voltage of VT2 so that the voltage across R12 is equal to that across R29. Similarly, the base emitter voltages of VT2 and VT6 cancel to stabilise the reference current. The output of the current sensing stage is OR-gated into the emitter of VT3 by MR10. C6 provides extra stabilisation of the loop in current limit mode.

The meter switching is entirely straightforward. RV4 on the voltage ranges or RV5 on the current ranges is adjusted to shunt the meter and obtain calibration. S1A and S1B switch the meter between voltage and current ranges. S2A on voltage and S2B on current short out part of the series chain to give the more sensitive meter ranges.

The circuit of the centre tap section, used only on 'D' option units, is shown in Fig. 3. On the 'D' option units, the auxiliary unregulated supply is regulated by R31 and MR14. This supply provides, via R34 and VT12, a constant current to the differential pair VT13 and VT14. These compare the centre tap voltage with a centre point voltage derived by divider R32 and R33. This differential pair drives the Darlington connected pair VT16 and VT17 which, in turn, drive the class 'B' push/pull output stage VT18, VT19, VT20 and VT21. R37 and VT15 form another current source, providing a dynamic load for VT16 and VT17. Output capacitors C8 and C9 are added to give good centre tap ripple and transient response. C10 and R39 determine the loop frequency response.

4.0 SETTING-UP PROCEDURE

Remove the cover from the unit by removing the two screws holding the carrying handle and the four small screws (two on each side) from the sides of the cover. Access to all preset potentiometers is gained through holes in the printed circuit board; their functions are marked on both sides of the board. Prior to switching on, zero the meter if necessary (see Safety Regulations 64.5 (a) 8 (a)).

Switch on the supply, set the variable voltage control fully clockwise and depress the 7·5V (15V on 423) push-button. Adjust RV2 (SET V) to give an output of 7·6V (15V on 423). Release the 7·5V (15V on 423) push-button and depress the 15V (30V on 423) button. With the variable voltage control still fully clockwise, check that the output voltage is 15·4 ±0·4V (30·8 ±0·8V on 423). Release the 15V (30V on 423) button and depress the 30V (60V on 423) push-button. With the variable voltage control still fully clockwise, check that this output voltage is 30·8 ±0·8V (61·5 ±1·5V on 423).

By means of the variable voltage control, set the output voltage to 30·0V (60·0V on 423). Adjust RV4 (SET METER V) so that the meter reads 30·0V (60·0V on 423) with both meter push-buttons released. By means of the variable voltage control, reduce the output voltage to 10·0V (20·0V on 423). Depress the lower meter push-button and check that the meter reads 10·0 ±0·2V (20·0 ±0·4V on 423). Release the lower meter button.

Set the variable voltage control fully clockwise and short circuit the unit through a d.c. ammeter. Adjust RV1 (SET A) to give a short circuit current of 0·55A (1·1A on 413). Release the 30V (60V on 423) push-button and depress the 15V (30V on 423) push-button. Check that the short circuit current is 1·1 ±0·1A (2·2 ±0·2A on 413). Release the 15V (30V on 423) push-button and depress the 7·5V (15V on 423) push-button. Check that the short circuit current is 2·2 ±0·2A (4·4 ±0·4A on 413).

Remove the short circuit, release the 7·5V (15V on 423) push-button and depress the 5·00V push-button. Adjust RV3 (SET 5V) to give an output of 5·00 ±0·01V.

Depress the upper meter push-button. Apply a load of 2·0A (4·0A on 413) and adjust RV5 (METER A) so that the meter reads 2·0A (4·0A on 413). Reduce the load current to 1·0A (2·0A on 413), depress the lower meter push-button and check that the meter reads 1·0 ±0·02A (2·0 ±0·04A on 413).

The unit is now set up. Replace the cover.

5.0 SPECIFICATION

Line Supply:		110, 120, 220, 240V ±10% 50-60Hz selected by external voltage selector
Outputs (selected by push-button):		
	413	5V ±1% at 1, 2 or 4A 0-7·5V at 1, 2 or 4A 0-15V at 1 or 2A 0-30V at 1A
	423	5V ±1% at 0·5, 1 or 2A 0-15V at 0·5, 1 or 2A 0-30V at 0·5 or 1A 0-60V at 0·5A
Line regulation:		< 0·02% of maximum output for 10% line change
Load Regulation:		< 0·05% of maximum output for 100% load change NOTE: Maximum output refers to the maximum voltage on the range selected.
Ripple and Noise:		< 1mV peak-to-peak
Output Impedance:		< 1mΩ at 1kHz
Temperature Coefficient:		< 0·02%/°C (typical)
Transient Response:		Recovers to 50mV within 20μs for full load step change
Current Limit:		Nominally 110% of selected full load current
Meter Range (selected by push-button):		
	413	0-10 and 0-30V; 0-2 and 0-6A
	423	0-20 and 0-60V; 0-1 and 0-3A
Centre Tap Tracking ('D' suffix only):		49 to 51% of total output ±100mV (down to 4V total output)
Centre Tap Line & Load Regulation, Ripple, Output Impedance & Temperature Coefficient:		As specified for full supply
Centre Tap Transient Response:		Recovers to 50mV within 30μs for full load step change
Operating Temperature Range:		0-45°C
Dimensions All Over Projections:		255mm deep x 180mm high x 153mm wide (10 x 7 x 6 inches)
Weight:	413 and 423:	4·4kg (9lbs 11oz)
	'D' options, add:	0·1kg (3·5oz)

PARTS LIST

Main Assembly Power Supply - see Fig. 2.

Circuit Ref.	Description	Value	Rating	Tol.	Type
Capacitors					
C8 (423D)	Electrolytic	100μ	35/40V	-10, +50%	Mullard 016
C8 (413)	Electrolytic	220μ	35/40V	-10, +50%	Mullard 017
C8 (413D)	Electrolytic	220μ	25V	-10, +50%	Mullard 017
C8 (423)	Electrolytic	100μ	100V	-10, +50%	I. T. T. EN12·12

Continued .....

PARTS LIST Main Assembly Power Supply - continued ----

Circuit Ref.	Description	Value	Rating	Tol.	Type
C9 (413/423)		Not fitted			
C9 (423D)	Electrolytic	100μ	35/40V	-10, +50%	Mullard 016
C9 (413D)	Electrolytic	220μ	25V	-10, +50%	Mullard 017
C13 (413/423)		Not fitted			
C13 (413D)	Electrolytic	220μ	35/40V	-10, +50%	Mullard 017
C13 (423D)	Electrolytic	100μ	100V	-10, +50%	I. T. T. EN12·12
Controls					
RV6 (413)	Wire Wound	50k	1W	10%	Colvern CLR4001
RV6 (423)	Wire Wound	100k	1W	10%	Colvern CLR4001
RV6 (413T)	Wire Wound	50k		5%	Bourns 3509
RV6 (423T)	Wire Wound	100k		5%	Bourns 3509
Transistors					
VT10, 11 (413)					2N3055
VT10, 11, 20, 21 (413D)					2N3055
VT10, 11 (423)					Motorola TE00461
VT10, 11, 20, 21 (423D)					Motorola TE00461
Miscellaneous					
T1 (413)	Transformer				W1557 (Weir)
T1 (423)	Transformer				W1558 (Weir)
BR1 (413)	Rectifier Bridge				Motorola MDA990-2

MAIN POWER SUPPLY PRINTED CIRCUIT BOARD - see Fig. 2

Resistors					
R1	Metal Oxide	1k3	½W	2%	Electrosil TR5
R2	Metal Oxide	1k2	½W	2%	Electrosil TR5
R3, 10	Metal Film	18k	½W	1%	Electrosil C5
R4	Metal Film	20k	½W	1%	Electrosil C5
R5, 6	Metal Film	7k5	½W	1%	Electrosil C5
R7	Metal Film	15k	½W	1%	Electrosil C5
R8, 12	Metal Oxide	2k7	½W	2%	Electrosil TR5
R9	Metal Film	11k	½W	1%	Electrosil C5
R11	Metal Film	8k2	½W	1%	Electrosil C5
R13	Metal Oxide	10k	½W	2%	Electrosil TR5
R14	Metal Oxide	5k6	½W	2%	Electrosil TR5
R15, 22	Metal Oxide	2k2	½W	2%	Electrosil TR5
R16, 18	Metal Oxide	1k5	½W	2%	Electrosil TR5
R17, 19	Metal Oxide	120R	½W	2%	Electrosil TR5
R20	Metal Oxide	680R	½W	2%	Electrosil TR5
R21	Metal Oxide	160R	½W	2%	Electrosil TR5
R23	Metal Oxide	27R	½W	2%	Electrosil TR5
R24	Metal Film	360R	½W	1%	Electrosil C5
R25, 42	Metal Oxide	47R	½W	2%	Electrosil TR5
R26	Metal Film	845R	½W	1%	Electrosil C5
R27 (413)	Metal Film	15k	½W	1%	Electrosil C5
R27 (423)	Metal Film	30k	½W	1%	Electrosil C5
R28 (413)	Metal Film	7k5	½W	1%	Electrosil C5
R28 (423)	Metal Film	15k	½W	1%	Electrosil C5
R29, 30 (413)	Wire Wound	0R5	3W	5%	C. G. S. PM3·5
R29, 30 (423)	Wire Wound	1R0	3W	5%	C. G. S. PM3·5
R43	Metal Oxide	470R	½W	2%	Electrosil TR5
R44	Metal Oxide	180R	½W	2%	Electrosil TR5
R45 (413)	Wire Wound	39R	3W	5%	C. G. S. PM3·5
R45 (423)	Wire Wound	82R	3W	5%	C. G. S. PM3·5

Continued .....

Main Power Supply Printed Circuit Board - continued -------

Circuit Ref.	Description	Value	Rating	Tol.	Type.
Capacitors					
C1	Electrolytic	470μ	40V	−10, +50%	Mullard 017-17471
C2 (413)	Electrolytic	4700μ	63V	−10, +50%	Mullard 072-18242
C2 (423)	Electrolytic	2200μ	100V	−10, +50%	Sprague WB35D222F10
C3	Plastic Film	2μ2	100V	−10, +10%	Mullard 344
C4, 6	Ceramic	2200p	500V	−20, +50%	Erie 831
C5, 7	Ceramic	1000p	500V	−20, +50%	Erie 831
C14	Ceramic	220p	500V	−20, +50%	Erie 831
Rectifiers					
MR1, 8, 17, 18					1N4002
MR2, 3, 4, 5 (423)					Westinghouse SIM3
MR2, 3, 4, 5 (413)		Not fitted			
MR6, 7, 9, 10					1N4148
MR11	Zener	5·6V	400mW	5%	BZY88C5V6
MR12	Zener	4·7V	400mW	5%	BZY88C4V7
MR13					Westinghouse SIM3
Transistors					
VT1, 2, 6					BC107
VT3 (413)					BCY70
VT3 (423)					Motorola MPSA56
VT4 (413)					BC107
VT4 (423)					Motorola MPSA06
VT5 (413)					BFX29
VT5 (423)					Motorola BD528
VT7, 8					BCY70
VT9 (413)					Motorola BD577
VT9 (423)					Motorola BD581
Preset Controls					
RV1, 2	Carbon	500R		20%	Morganite 62H
RV3	Carbon	5k0		20%	Morganite 62H
RV4	Carbon	470R		20%	Morganite 62H
RV5	Carbon	1k0		20%	Morganite 62H
Switch Assembly					
S1 to S7					Lipa & Isostat CD15/MO7369
Fuse					
FS1	Anti-surge	0·5A (240V mains)			Beswick TCD123
FS1	Anti-surge	1·0A (120V mains)			Beswick TDC123

AUXILIARY PRINTED CIRCUIT BOARD ('D' OPTIONS ONLY) - see Fig. 3.

Resistors					
R31	Metal Oxide	1k0	½W	2%	Electrosil TR5
R32, 33	Metal Film	6k8	½W	1%	Electrosil C5
R34	Metal Oxide	56k	½W	2%	Electrosil TR5
R35	Metal Oxide	27k	½W	2%	Electrosil TR5
R36	Metal Oxide	3k3	½W	2%	Electrosil TR5
R37 (423)	Metal Oxide	1k5	½W	2%	Electrosil TR5
R37 (413)	Metal Oxide	820R	½W	2%	Electrosil TR5
R38	Metal Oxide	4k7	½W	2%	Electrosil TR5
R39	Metal Oxide	120R	½W	2%	Electrosil TR5
R40, 41	Metal Oxide	27R	½W	2%	Electrosil TR5

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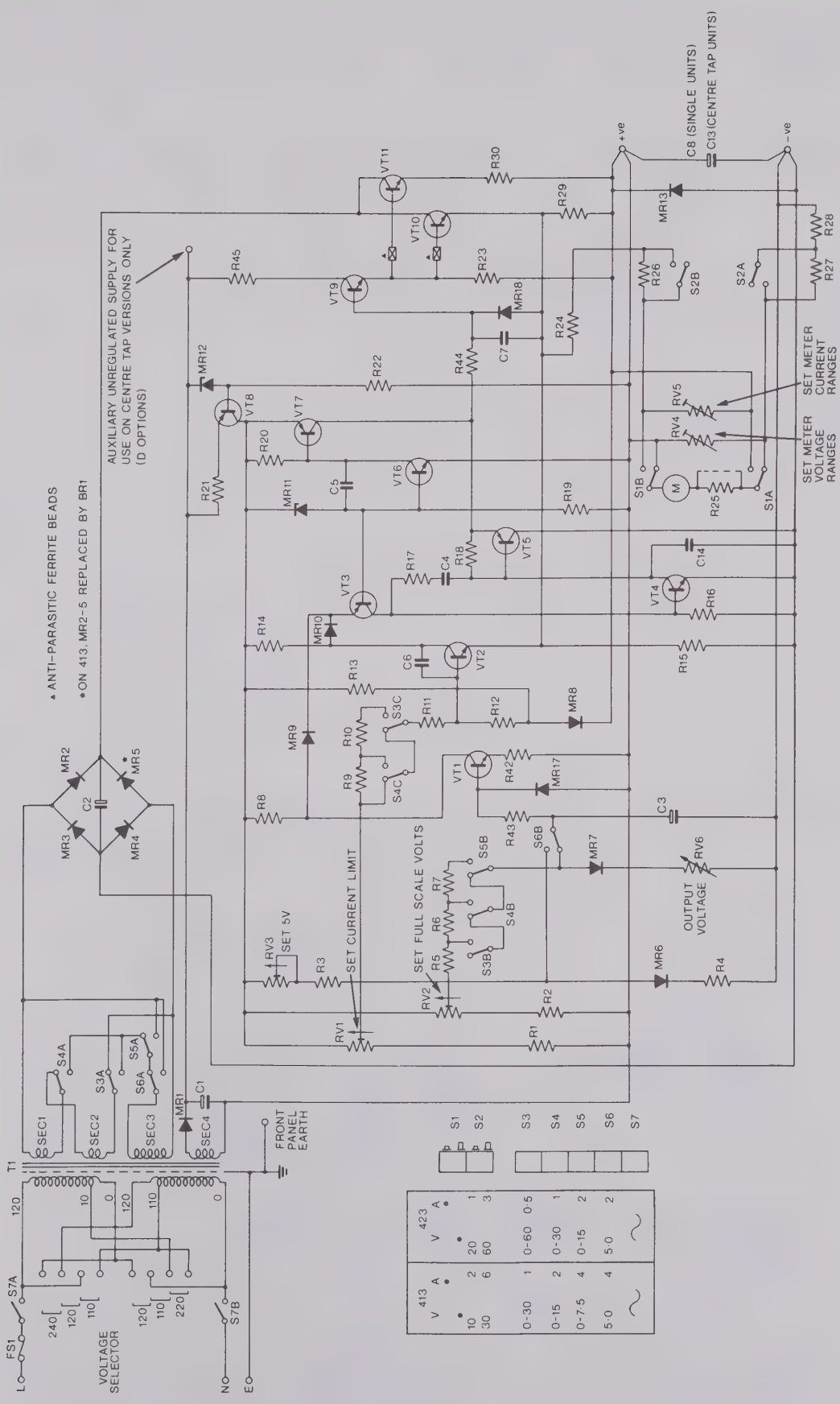

Fig. 2 Circuit Diagram of Main Assembly and Printed Circuit Board

Auxiliary Printed Circuit Board ('D' Options Only) - continued --------

Circuit Ref.	Description	Value	Rating	Tol.	Type
Capacitors					
C10 (413)	Ceramic	390p	500V	20%	Erie 831
C10 (423)	Ceramic	1000p	500V	20%	Erie 831
C11	Ceramic	2200p	500V	20%	Erie 831
C12	Plastic Film	0·22μ	100V	20%	Mullard 344-25224
C15	Plastic Film	0·01μ	100V	20%	Mullard 344-41103
Diodes					
MR14	Zener	5·6V	400mW	5%	BZY88C5V6
MR15,16					1N4148
Transistors					
VT12,13,14,15					BCY70
VT16,17					BC107
VT18					Motorola BD557
VT19					Motorola BD578

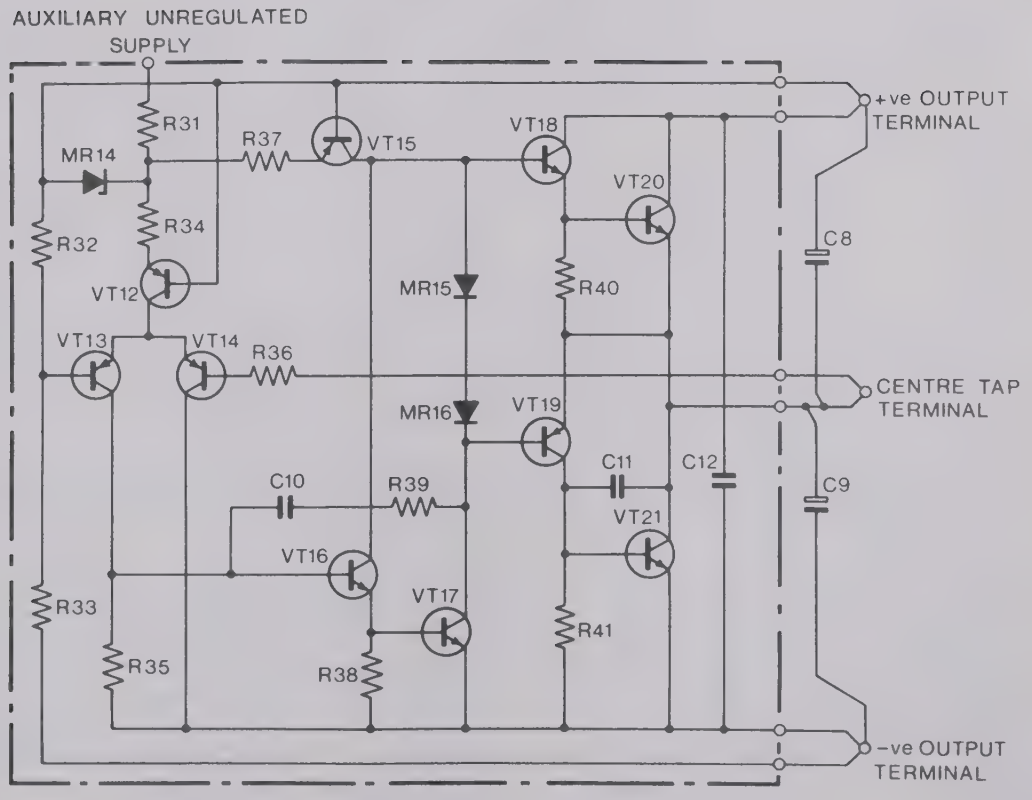

Fig. 3 Circuit Diagram of Auxiliary Printed Circuit Board ('D' Options only)

IEC Clause

63 1. The apparatus described in this manual is safety class 1 (IEC classification).

Accessible metal parts which are connected to the protective earth terminal indirectly are:- The cover and the heat sink.

64.1 2. The apparatus has been designed and type tested according to IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The present instruction manual contains information and warnings which shall be followed by the user to ensure safe operation and to retain the apparatus in safe condition.

64.2 (a) 3. If the unit is to be connected to the main supply by fixed wiring, rather than via a mains plug, then the protective earth wire in the 3-core mains lead shall be connected to a protective conductor before any other connection is made.

64.3 (a) 4. Before switching on the apparatus, make sure that it is set to the voltage of the mains supply.

64.3 (c) 5. Ensure that an appropriate mains plug is correctly connected to the captive 3-core cable provided with the unit. Connections are:- brown = live, green/yellow = earth and blue = neutral. Then ensure that the mains socket to be used has a correctly connected protective earth contact. Do not use extension cords without protective earth conductors.

64.3 (a) 6 (a) If the unit is to be used with live measuring or load circuits which have protective earth terminals, ensure that all protective earth terminals are connected to a protective conductor (the front panel green terminal may be used for this purpose) prior to switching on.

64.3 (e) 6 (b) If the unit is to be used with live measuring or load circuits which do not have protective earth terminals, ensure that the unit mains plug is inserted before making connections between the unit output terminals and such circuits.

64.4 (a) 7. WARNING

(a) Any interruption of the protective conductor inside or outside the unit, or disconnection of the protective earth connection, is likely to render the apparatus dangerous. Intentional interruption is prohibited.

64.4 (b) (b) The output of the power supply unit is fully floating and it may be used in series with other power supply units to generate high DC voltages up to 300V DC.

Such voltages are exceedingly hazardous and great care should be taken to shield the output terminals for such use. On no account should the output terminals be touched when the unit is switched on under such use. All connections to the terminals must be made with the power switched off.

64.5 (a) 8 (a) Ensure that the unit is disconnected from the mains supply (switching off the unit by the front panel ON/OFF switch is not sufficient) before the cover is removed for the purposes of maintenance or setting up - otherwise dangerous voltages are accessible.

Unless unavoidable, do not reconnect the unit to the mains supply until the repair is complete and the cover replaced.

It is recognised that, for fault finding and setting up, the mains supply will require reconnection and the unit will be switched on - thus, this work may only be carried out by a skilled person who is aware of the hazard involved. When this work is completed, disconnect the mains supply before replacing the cover.

64.5 (b) (b) Capacitors inside the apparatus (especially C2 and C8 on the 423 or C2 and C13 on the 423D) may remain charged to a voltage >42V (IEC extra-low voltage for safety) after removal of the mains power. These should be discharged before commencing repair work.

64.5 (c) (c) Use only the correctly rated fuses as specified in the parts list for replacement. On no account use mended fuses or short circuited fuse holders.

64.6 9. If the apparatus is defective or if it has been subjected to abnormal mechanical stresses, it is likely that the safety protection may be impaired, in which case, the unit should be withdrawn from use and returned to the factory for recheck and repair.

This is particularly important if there are external signs of mechanical damage.

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